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Variable Stars in M31's Globular Clusters

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Abstract. MEGA is a next generation microlensing and variable star survey of M31. Our trial image subtractions show that we can detect new variable stars in M31's globular clusters (GCs). Technical issues as well as possible implications for stellar evolution and galaxy formation theory are discussed. We may also find new GCs based on variability.

1. Introduction

Globular clusters (GCs) are variable because they contain variable stars. Many types of variable star found in Milky Way GCs, like Cepheids and Miras, have yet to be discovered in M31 GCs. Rare specimens of period-changing stars are particularly important to test stellar evolution theory (Wallerstein 2002). Variable stars in M31 GCs can also be used to probe the epoch of galaxy formation. For example, the Cepheids are common in GCs with mostly blue horizontal branch (HB) stars, which is a possible indicator of cluster age. M31 GCs with similar ages may form groups, and thus implicate galaxy halo accretion processes. This result could strongly favor age as the causative 2nd parameter of HB color, perhaps ending a classic debate. Last, characteristic integrated variability or association with a known type of GC variable may be a way to find new GCs.

MEGA is a next generation microlensing and variable star survey of M31. A typical M31 GC should contain a few bright variable stars that we can detect. Figure 1 shows a feasibility test which supports this hypothesis. Both of these M31 GCs cataloged by Barmby et al. (2000) harbor bright variable stars. Note, however, that both positive and negative flux variations are found on spatial scales smaller than the point spread function (PSF) due to source confusion. We desire accurate classifiable light curves, but photometry of confused sources in subtracted image data is an unsolved software problem. This is an important issue for microlensing. We estimate that the loss in detection efficiency due to source confusion could reduce MEGA's total yield of microlensing events by as much as ∼10%. The development of new software that performs crowded-field PSF-fitting photometry on subtracted images might lead us to recover much of this loss. In this regard the variable stars in M31's GCs are excellent test cases.

References

Barmby, P. et al. 2000, AJ, 119, 727
Wallerstein, G. 2002, PASP, 114, 689

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Figure 1. Image subtraction experiment based on four high-quality 500 s Kitt Peak 4-m mosaic images of M31 GCs 198-249 and 137-195; each frame is 30×30 arcsec. The T=0 images are the references from which the others were subtracted. The subtracted images are ordered by the amount of time passed relative to the reference frame. The T=+5 min subtractions illustrate the noise properties of the data. In a typical sense, the T=+10 day subtractions are sensitive to Type II Cepheids; the T=+1 year subtractions reveal semiregulars and Miras.